

Patent claims

1. A power supply device having several switch-mode power supplies connected in parallel to supply at least one load (32), each switch-mode power supply generating an output current I_0 and an output voltage $U_0(I_0, R_L)$ that is a function of the output current I_0 and a load resistance R_L , and having a control device for each switch-mode power supply, characterized in that the control device has a first stage (50) having a P element (54) that receives a P element input voltage which is derived from the output voltage $U_0(I_0, R_L)$, and generates a P element control voltage U_{VS} , that is used to control the respective switch-mode power supply, the first stage being active when $0 \leq I_0 \leq I_{0P}$,
a second stage (60) having a current imaging circuit which reproduces the output current I_0 of the respective switch-mode power supply and generates an output current control voltage U_P which is used to control the respective switch-mode power supply, the second stage being active when $I_{0P} \leq I_0 \leq I_{0S}$, and
a third stage (70) having an amplifier circuit (74) which amplifies a signal proportional to the output current I_0 and generates an amplified output current control voltage $m \cdot U_S$ which is used to control the respective switch-mode power supply, the third stage being active when $I_{0S} \leq I_0 \leq I_K$.
2. A power supply device according to claim 1, characterized in that the second stage is also active when $I_{0S} \leq I_0$.
3. A power supply device according to claim 1 or 2, characterized in that I_{0P} is a first threshold value of the output current I_0 which characterizes the limit of a normal operating range; I_{0S} is a second threshold value of the output current I_0 which characterizes the limit of an operating range with a heavier load; and I_K characterizes a short circuit current limitation.

4. A power supply device according to one of the above claims, characterized in that the control device has a pulse width modulation circuit (80) which receives the P element control voltage U_{VS} , the output current control voltage U_p and the amplified output current control voltage U_S and generates a control signal U_T for the respective switch-mode power supply in response thereto.
5. A power supply device according to one of the above claims, characterized in that the first stage (50) has a voltage divider (51, 52, 53) that generates a P element input voltage proportional to the output voltage U_0 .
6. A power supply device according to claim 5, characterized in that the P element (54) of the first stage (50) has an operational amplifier, one of whose inputs receives the P element input voltage and whose other input receives a first reference voltage U_{REF1} and whose output emits the P element control voltage U_{VS} .
7. A power supply device according to claim 4 and 6, characterized in that the operational amplifier (54) is connected to the pulse width modulation circuit (80) via a blocking diode (36).
8. A power supply device according to one of the above claims, characterized in that the second stage (60) has a transformer element (62) that is connected in parallel to the main transformer element (26) of the respective switch-mode power supply and generates an output signal that is proportional to the output current I_0 of the switch-mode power supply.
9. A power supply device according to claim 8, characterized in that downstream from the transformer element (62), a zener diode (63) and an RC circuit (64, 65) are connected which generate the output current control voltage U_p as a function of the transformer output signal when $I_0 \geq I_{0P}$, U_p being proportional to I_0 .
10. A power supply device according to one of the above claims, characterized in that the third stage (70) is connected downstream from the second stage (60) and the output

current control voltage U_p , which is proportional to the output current I_0 of the switch-mode power supply, forms the input signal of the third stage (70).

11. A power supply device according to one of the claims 1 to 9, characterized in that the third stage (70) is connected in parallel to the second stage (60) and has a further current imaging circuit which reproduces the output current I_0 of the switch-mode power supply.
12. A power supply device according to claim 10 or 11, characterized in that the third stage (70) has an amplifier circuit (74) one of whose inputs is connected to the current imaging circuit via a further RC circuit (72, 73) and whose other input is connected to the reference voltage U_{REF3} and whose output emits the amplified output current control voltage mU_s .
13. A power supply device according to claim 12, characterized in that the amplifier circuit (74) of the third stage (70) is designed in such a way that it has a high amplification factor $m \gg 1$.